What is the effect of replacing a high-carbohydrate diet with a high-MUFA diet in type 2 diabetics?

Conclusion

Moderate evidence indicates that increased monounsaturated fatty acid (MUFA) intake, rather than high carbohydrate intake, may be beneficial for persons with type 2 diabetes. High MUFA intake, when replacing a high carbohydrate intake, results in improved biomarkers of glucose tolerance and diabetic control.

Grade: Moderate

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

To determine the effects of replacing a high-carbohydrate (CHO) diet with a high-monounsaturated fat (MUFA) diet in persons with type 2 diabetes (T2D), five randomized controlled trials (RCTs) published since 2004 were reviewed. These RCTs were conducted in the US and Europe and ranged in size from 11 to 95 subjects. Two studies were methodologically strong (Brehm, 2009; Gerhard, 2004) and three were methodologically neutral (Brunerova, 2007; Rodriguez-Villar, 2004; and Shah, 2005).

In persons with T2D, a high-MUFA diet compared to high-CHO diet decreased blood low-density lipoprotein cholesterol (LDL-C) and triglycerides (TG) (Rodriguez-Villar, 2004), increased high-density lipoprotein cholesterol (HDL-C) (Brunerova, 2007), and decreased fasting blood glucose (FBG) and hemoglobin A1c (HbA1c) (Brunerova, 2007). On the other hand, when high MUFA and CHO diets were also low-calorie or weight-loss diets, the results were more difficult to interpret. Brehm et al (2008) found no significant (NS) differences in fasting glucose, insulin,HbA1c or HDL-C between the MUFA and CHO groups. Both groups improved compared to baseline due to decreased caloric intake (200 to 300kcal per day). Gerhard et al (2004) did not find any significant difference in blood lipids or glycemic control in a comparison of high MUFA vs. high CHO diets in T2D subjects; however, in this case, the two diet interventions were not isocaloric and the MUFA diet was a higher-calorie diet. Shah et al (2005) measured the effects of high MUFA vs. CHO on blood pressure (BP) in persons with T2D and found that long-term consumption of a high-CHO may modestly raise BP in persons with T2D.

Evidence Summary Paragraphs

Brehm et al, 2008 (positive quality) This was an RCT to investigate the effects of high monounsaturated fatty acid [MUFA, 45% energy as CHO, 15% protein (PRO) and 40% fat (20% as MUFA)] and high carbohydrate (CHO, 60% energy as CHO, 15% PRO and 25% fat) diets on body weight and glycemic control in overweight or obese men and women (N=124, age=56.5±0.8 years, body mass index (BMI)=35.9±0.3kg/m^2 and HbA1C = 7.3±0.1%) with T2D over a one-year period. Anthropometric and metabolic parameters were assessed at baseline and after four, eight and 12 months. Subjects met alternating with each of three study dietitians throughout the year for either individual counseling or a group session. Food intake was monitored by detailed three-day food records. Subjects wore pedometers and recorded pedometer readings and physical activity concurrent with their food records. Food records showed that both groups had similar energy intake but a significant difference in MUFA intake. Both groups had similar weight loss over one year (-4.0±0.8 vs. -3.8±0.6kg) and comparable improvement in body fat, waist circumference (WC), diastolic blood pressure (DBP), HDL-C, HbA1C and fasting glucose and insulin. A follow-up assessment of a subset of participants (N=36) was conducted 18 months after completion of the 52-week trial. These participants maintained their weight loss and HbA1C during the follow-up period. Authors conclude that in individuals with T2D, high-MUFA diets are an alternative to conventional lower-fat, high-CHO diets with comparable beneficial effects on body weight, body composition, cardiovascular risk factors and glycemic control.

Brunerova et al, 2007 (neutral quality) This was an RCT conducted in the Czech Republic to elucidate the impact of two types of individualized weight reduction diets on weight loss and on parameters of glucose and lipid metabolism in 31obese, non-diabetic (mean age 53.6±3.5 years) and 27 obese, adults with T2D (mean age 54.5±3.5 years). For three months, subjects were assigned to either a conventional diet, which was a standard diabetic diet consisting of 60% CHO, 10% PRO and 30% fat (10% MUFA, 10% PUFA, 10% SFA), or an experimental diet, which was a high-fat diet enriched with MUFA, consisting of 45% CHO, 10% PRO, and 45% fat (22.5% MUFA, 11.25% PUFA, and 11.25% SFA). Both diets were individually calculated for calorie content and contained less than 300mg cholesterol per day. Subjects visited with a dietitian every two weeks for compliance monitoring through diet records, and with a physician every month. All enrolled subjects completed the trial. After three months, body weight, waist-hip ratio (WHR), total body fat, levels of C-peptide, TG and the Homeostasis Model Assessment (HOMA-IR) for insulin resistance decreased in all subjects ($P<0.001$). Additionally, for diabetic subjects on the MUFA-enriched diet,FBG and HbA1c values significantly decreased ($P<0.01$) and HDL-C significantly increased ($P<0.05$), but were NS different from the conventional diet group.

Gerhard et al, 2004 (positive quality) This randomized crossover trial conducted in the US compared two ad-libitum diets in patients with T2D to ascertain which diet would lead to greater weight loss and greater improvements in dyslipidemia and glycemic control. Eight women and three men (mean age 50.4±4.8 years) were enrolled in the trial. Subjects were fed either a low-fat (20% fat, 8.0% as MUFA, 65% CHO) or high-MUFA (40% fat, 25% as MUFA, 45% CHO) diet in random order for six weeks. The two diets separated by a six- to 12-week washout period. Subjects consumed significantly more (P<0.05) calories (212kcal), fat, SFA, MUFA and cholesterol while on the high-MUFA diet; they consumed significantly less (P<0.05) CHO and fiber while on that diet compared to when on the low-fat diet. Body weight decreased significantly on the low-fat diet (1.53kg, P<0.001). Plasma TC, LDL-C and HDL-C and triacylglycerol concentrations, glycemic control, and insulin sensitivity did not differ significantly between the two test diets. (Confounder: One group consumed less calories, with unequal intakes of more than 250kcal per day by low-fat group.)

Rodriguez-Villar et al, 2004 (neutral quality) This was a randomized crossover trial conducted in Spain, compared the effects of a high€CHO diet (CHO, 28% energy from from fat) and a high-monounsaturated fatty acid (MUFA, olive oil) diet (40% energy from fat, less than 10% energy from CHO) on LDL oxidative resistance among 22 free-living adults (12 men and 10 women) with T2D. During a six-week pre-inclusion period, individuals consumed their usual diabetic diet, which was low in SFA and high in CHO, followed by assignment to six weeks of isocaloric test diets in crossover fashion, without any washout period between diets. Body weight, glycemic control, total TG, TC, LDL-C and HDL-C levels were similar after both diets; the high-MUFA diet lowered very-low-density lipoprotein (VLDL) cholesterol by 35% (P=0.023) and VLDL TG by 16% (P=0.016) compared with the high-CHO diet.

Shah et al, 2005 (neutral quality) This was a randomized crossover study. This study compared the effect of feeding a carefully controlled isoenergic high-CHO (H-CHO; 55% energy as CHO, 30% as fat and 10% as MUFA) and high-MUFA (H-MUFA; 45% energy as fat, 25% as MUFA and 40% as CHO) diet each on BP in 42 T2D subjects for six weeks, in the US. In phase 2 of the study, 21 subjects (N=13 on H-CHO, N=8 H-MUFA) continued the diet they received during the second phase for an additional eight weeks. Repeat-measuresANOVA showed that BP during the last three days of each phase was similar after six weeks of the H-CHO and H-MUFA diets (SBP: 128±16 vs. 127±15mmHg, P=0.9; DBP: 75±7 vs. 75±8mmHg, P=0.7). The second phase of the diet interventions did not meet inclusion criteria for analysis (less than 10 subjects in the H-MUFA diet group).

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Author, Year, Study Design, Class, Rating	Study Duration	Study Population, Demographics	Intervention	Significant Outcomes	Limitations
Brehm BJ, Lattin BL et al, 2009 Study Design: Randomized Controlled Trial Class: A Rating:	One year.	N=95. N=52 ↑-CHO (17 men; 35 women). N=43 ↑-MUFA (17 men; 26 women). Age: 56.5±0.8 years. BMI: 35.9±0.3kg/m^2. HbA1c: 7.3±0.1% T2D (not on insulin). Attrition: 23%.	MUFA vs. CHO. Subjects assigned two diets, ~1,550kcal per day, for 52 weeks (% energy): • ↑ MUFA: 45% CHO, 15% PRO, 40% Fat (20% MUFA) • ↑ CHO: 60% CHO, 15% PRO, 25% Fat. Diets contained similar amounts of PRO, SFA and cholesterol. Intent to treat.	At 52 weeks: No difference between diet groups for weight loss, BMI, Δ in body composition, BP, HbA1c and lipid profile.	None.
Brunerova et al 2007 Study Design: Randomized Controlled Trial	Three months.	N=58 subjects. N=31 obese, non-diabetic; mean age, 53.6±3.5 years. N=27 obese, T2D	MUFA vs. CHO: • Conventional diet: Standard diabetic diet [60% CHO, 10% PRO, 30% Fat (10% MUFA, 10%	After three months: • ↓ FBG and HbA1c values • ↑ HDL-C (P<0.05) • ↓ body weight, WHR, total body fat,	Metabolic effects of the macronutrient composition may be masked by weight

Class: A Rating:		adults not on insulin; mean age 54.5±3.5 years. All enrolled subjects completed the trial. Location: Czech Republic.	PUFA, 10% SFA)] • Experimental diet: High-fat enriched with MUFA [45% CHO, 10% PRO, 45% Fat (22.5% MUFA, 11.25% PUFA and 11.25% SFA)].	levels of C-peptide • ↓ TG and HOMA-R in all groups (P<0.01). Diabetic subjects on the MUFA diet: • ↓ FBG and HbA1c values (P<0.01) • ↑ HDL-C (P<0.05).	reduction.
Gerhard et al 2004 Study Design: Randomized Crossover study Class: A Rating:	Six-week intervention, six- to 12-week washout period.	N=11 adults (eight women; three men) with T2D. Mean age: 50.4±4.8 years. Location: United States.	MUFA vs. CHO. Two test diets fed in random order (% energy): • Low-fat (20% fat, 65% CHO) • High-MUFA (40% fat, 25% MUFA, 45% CHO).	High-MUFA subjects consumed more (P<0.05) calories (212kcal), fat, SFA, MUFA and cholesterol. Plasma TG, glycemic control and insulin sensitivity did not differ between the two diets. ↓ consumption of CHO and fiber on the low-fat diet (P<0.05). ↓ body weight on the low-fat diet (1.53kg, P<0.001). ↓ plasma total, LDL-C and HDL-C on both diets (NS).	Authors indicate both diets mirror diets in the real world.
Rodriguez-Villar et al 2004 Study Design: Randomized Crossover Trial Class: A Rating:	Six-week intervention.	N=22 (12 men; 10 women) free-living subjects with T2D. HbA1c: <8%. Mean age: 61±7 years. Attrition rate: 15%. Location: Spain.	MUFA vs. CHO: Consumed usual diabetic diet (↓ SFA and ↑ CHO) for six weeks. Followed by test diets in crossover fashion, without washout period for an additional six weeks. Test diets (% energy): • High-CHO (28% fat, % MUFA). • High-MUFA diet (40% fat, 25% MUFA).	Body weight, glycemic control, total TG, TC, LDL-C and HDL-C levels were similar after both diets. ↑-MUFA vs. ↑ CHO diet: • ↓ VLDL-C by 35% (P=0.023) • ↓ VLDL-TG by 16% (P= 0.016).	Relatively small sample size; no washout period used between diets.
Shah M, Adams-Huet B et al, 2005 Study Design: Randomized Controlled Trial Class: A	Six-week intervention.	N=42 patients with T2D. Location: United States.	CHO vs. MUFA. Two isoenergenic diets (% energy): 1. High-CHO: 55% CHO, 30% fat, 10% MUFA. 2. High-MUFA: 45% fat, 25% MUFA, 40% CHO.	At six weeks: No difference in BP between diet groups.	Short duration study.

Rating:			Measured effect on BP.		

Research Design and Implementation Rating Summary
For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

Brehm BJ, Lattin BL, Summer SS, Boback JA, Gilchrist GM, Jandacek RJ, D'Alessio DA. One-year comparison of a high-monounsaturated fat diet with a high-carbohydrate diet in type 2 diabetes. *Diabetes Care*. 2009 Feb; 32 (2): 215-220.

Brunerova L, Smejkalova V, Potockova J, Andel M. A comparison of the influence of a high-fat diet enriched in monounsaturated fatty acids and conventional diet on weight loss and metabolic parameters in obese non-diabetic and Type 2 diabetic patients. *Diabet Med.* 2007 May;24(5):533-40. Epub 2007 Mar 22.

Gerhard GT, Ahmann A, Meeuws K, McMurry MP, Duell PB, Connor WE. Effects of a low-fat diet compared with those of a high-monounsaturated fat diet on body weight, plasma lipids and lipoprotiens, and glycemic control in type 2 diabetes. Am J Clin Nutr 2004;80(3):668-73.

Rodríguez-Villar C, Pérez-Heras A, Mercadé I, Casals E, Ros E. Comparison of a high-carbohydrate and a high-monounsaturated fat, olive oil-rich diet on the susceptibility of LDL to oxidative modification in subjects with Type 2 diabetes mellitus. *Diabet Med.* 2004 Feb;21(2):142-9.

Shah M, Adams-Huet B, Bantle JP, Henry RR, Griver KA, Raatz SK, Brinkley LJ, Reaven GM, Garg A. Effect of a high-carbohydrate versus a high--cis-monounsaturated fat diet on blood pressure in patients with type 2 diabetes. *Diabetes Care*. 2005 Nov; 28(11): 2,607-2,612.